B2 cont.

of the body region is substantially symmetric with the doping profile on an opposite side of said centerplane.

STATUS OF CLAIMS:

By the above amendment claims 1 and 14 have been amended. Accordingly, claims 1-16, 25 and 26 remain pending herein.

A separate sheet entitled "Version with Markings to Show Changes Made" is provided to illustrate the addition and deletion of claims.

Support for a trench MOSFET transistor device having a non-uniform body region can be found at various points throughout the present specification. See, e.g., Figs. 8A-10B and associated discussion in paragraphs [0048] to [0051], in which the p-type body dopant is introduced by implantation, leading to a non-uniform doping profile. (In contrast, also note Figs. 11A-11B and associated discussion in paragraph [0052], in which the p-type body dopant is epitaxially introduced, and hence uniformly doped.)

Entry of the above amendment of claim 1 is respectfully requested as the amendment does not introduce new matter, as it is believed to place the application in condition for allowance, and as it is believed to place the application in better condition for appeal.

REMARKS

A. Rejection of Claims 1-4, 6-8 and 10-16 (and 26) under 35 U.S.C. 103(a)

Claims 1-4, 6-8 and 10-16 (and 26)) are rejected under 35 U.S.C. 103(a) as being obvious over Mogi et al. (U.S. Patent No. 4,250,519) in view of Vinson (U.S. Patent No. 4,116,720). The Applicants respectfully traverse this rejection and its supporting remarks.

Claims 1 and 14, the only independent claims presently under rejection, read as follows:

> 1. (Amended) A trench MOSFET transistor device comprising:
> a drain region of a first conductivity type;
> a body region of a second conductivity type provided over said drain region, said drain region and said body region forming a first junction;
> a source region of said first conductivity type provided over said body region, said source region and said body region forming a second junction;
> source metal disposed on an upper surface of said source region;

a trench extending through said source region, through said body region and into said drain region; and

a gate region comprising an insulating layer lining at least a portion of said trench and a conductive region within said trench adjacent said insulating layer,

wherein (a) said body region is separated from said source metal, and *(b) a doping profile along a line normal to upper and lower surfaces of said device is such that (i) the doping profile is non-uniform within the body region, and (ii) within said body region and within at least a portion of said source and drain regions, the doping profile on one side of a centerplane of the body region is substantially symmetric with the doping profile on an opposite side of the centerplane.*

14. (Amended) A trench MOSFET transistor device comprising:

a silicon drain region of N-type conductivity;

a silicon body region of P-type conductivity provided over said drain region, said drain region and said body region forming a first junction;

a silicon source region of N-type conductivity provided over said body region, said source region and said body region forming a second junction;

source metal disposed on an upper surface of said source region;

a trench extending through said source region, through said body region and into said drain region; and

a gate region comprising a silicon dioxide layer lining at least a portion of said trench and a doped polycrystalline silicon region within said trench adjacent said silicon dioxide layer,

wherein (a) said body region is separated from said source metal by said source region, (b) said source and drain regions comprise the same doping material, (c) said source and drain regions have peak net doping concentrations that are greater than a peak net doping concentration of said body region, and (d) *a doping profile along a line normal to upper and lower surfaces of said device is such that, (i) the doping profile is non-uniform within the body region, and (ii) within said body region and within at least a portion of said source and drain regions, the doping profile on one side of a centerplane of the body region is substantially symmetric with the doping profile on an opposite side of said centerplane.*

In brief, it is the Office's contention that, while Mogi et al. may not teach limitation "(b)" in claim 1 (and hence limitation "(d)" in claim 14), Vinson does teach this feature "for the specific purpose of retaining electrical symmetry." See Office Action at p. 4. The Applicants respectfully traverse this rejection and its supporting remarks.

In order to establish a *prima facie* case of obviousness under 35 U.S.C. 103, the references, when combined, must teach or suggest all limitations of the claims. Moreover, there must be some suggestion or motivation to modify/combine the references. See MPEP §2143.

Mogi et al. and Vinson, however, do no not teach or suggest all limitations of claims 1 and 14 as presently amended. For example, Vincent proposes a device (i.e., the device of Figs. 4A-4C), in which "the channel region does *not* have a graded

concentration profile and therefore will have symmetrical electrical characteristics." Col. 4, lines 36-39 (emphasis added). See also, col. 6, lines 28-32 of Vincent: "Such a field effect transistor can be achieved without the formation of a graded dopant concentration in the channel between the source and drain areas of the transistor, thereby retaining electrical symmetry."

Hence, in contrast to the presently claimed invention, Vincent does not teach or suggest a symmetric trench MOSFET transistor device in which the body region is non-uniformly doped. Actually, Vincent teaches to the contrary, suggesting that a uniform concentration profile is to be used in the body region to achieve symmetrical electrical characteristics.

It is also noted that the device of Mogi et al. has a uniform body dopant concentration, as it is an epitaxial base device. Therefore, Mogi et al. also teaches away from a non-uniform body doping profile as presently claimed, along with Vincent.

For at least the above reasons, it is respectfully submitted that Mogi et al. and Vinson, even when combined, do not teach or suggest all of the present limitations of claims 1 and 14.

For at least the above reasons, it is respectfully submitted that independent claims 1 and 14 are patentable over Mogi et al. and Vinson. Claims 2-4, 6-8, 10-13, 15, 16 and 26 depend, either directly or indirectly, from claims 1 and 14 and are therefore patentable over Mogi et al. and Vinson for at least the same reasons as claims 1 and 14.

Accordingly, Applicants respectfully request reconsideration and withdrawal of the outstanding rejection of claims 1-4, 6-8 and 10-16 over Mogi et al. in view of Vinson.

B. Rejection of Claim 5 under 35 U.S.C. 103(a)

Claim 5 is rejected under 35 U.S.C. 103(a) as being obvious over Mogi et al. in view of Vinson and further in view of Seki (U.S. Patent No. 5,025,293). This rejection is respectfully traversed for the following reasons.

As indicated above, claim 1 is patentable over Mogi et al. and Vinson, at least in that Mogi et al. and Vinson neither teach nor suggest a trench MOSFET transistor device in which a doping profile along a line normal to upper and lower surfaces of the device is such that (i) the doping profile is non-uniform within the body region, and (ii) within the

body region and within at least a portion of the source and drain regions, the doping profile on one side of a centerplane of the body region is substantially symmetric with the doping profile on an opposite side of the centerplane.

Seki does not make up for these deficiencies in Mogi et al. and Vinson. Therefore, claim 1 is patentable over Mogi et al., Vinson and Seki as well. Claim 5 depends indirectly from claim 1 and is therefore patentable over these references for at least the same reasons as claim 1.

Accordingly, Applicants respectfully request reconsideration and withdrawal of the outstanding rejection of claim 5 over Mogi et al. in view of Vinson and further in view of Seki.

C. Rejection of Claim 9 under 35 U.S.C. 103(a)

Claim 9 is rejected under 35 U.S.C. 103(a) as being obvious over Mogi et al. in view of Vinson and further in view of Wolf et al. (ISBN 0-9616721-6-1). This rejection is respectfully traversed for the following reasons.

As indicated above, claim 1 is patentable over Mogi et al. and Vinson, at least in that Mogi et al. and Vinson neither teach nor suggest a trench MOSFET transistor device in which a doping profile along a line normal to upper and lower surfaces of the device is such that (i) the doping profile is non-uniform within the body region, and (ii) within the body region and within at least a portion of the source and drain regions, the doping profile on one side of a centerplane of the body region is substantially symmetric with the doping profile on an opposite side of the centerplane.

Wolf et al. does not make up for these deficiencies in Mogi et al. and Vinson. Therefore, claim 1 is patentable over Mogi et al., Vinson and Wolf et al. Claim 9 depends indirectly from claim 1 and is therefore patentable over these references for at least the same reasons as claim 1.

Accordingly, Applicants respectfully request reconsideration and withdrawal of the outstanding rejection of claim 9 over Mogi et al. in view of Vinson and further in view of Wolf et al.

D. Rejection of Claim 25 under 35 U.S.C. 103(a)

Claim 25 is rejected under 35 U.S.C. 103(a) as being obvious over Mogi et al. in view of Vinson and further in view of Baliga (ISBN: 0-89464-799-7) and van Loon et al. (U.S. 4,219,835). This rejection is respectfully traversed for the following reasons.

As indicated above, claim 1 is patentable over Mogi et al. and Vinson, at least in that Mogi et al. and Vinson neither teach nor suggest a trench MOSFET transistor device in which a doping profile along a line normal to upper and lower surfaces of the device is such that (i) the doping profile is non-uniform within the body region, and (ii) within the body region and within at least a portion of the source and drain regions, the doping profile on one side of a centerplane of the body region is substantially symmetric with the doping profile on an opposite side of the centerplane.

Neither Baliga nor van Loon et al. make up for these deficiencies in Mogi et al. and Vinson. Therefore, claim 1 is patentable over Mogi et al., Vinson and Wolf et al. Claim 25 depends indirectly from claim 1 and is therefore patentable over these references for at least the same reasons as claim 1.

Accordingly, Applicants respectfully request reconsideration and withdrawal of the outstanding rejection of claim 25 over Mogi et al. in view of Vinson and further in view of Baliga and van Loon et al.

CONCLUSION

Applicants submit that claims 1-16, 25 and 26 are presently in condition for allowance, early notification of which is earnestly solicited. Should the Examiner be of the view that an interview would expedite consideration of this Amendment or of the application at large, request is made that the Examiner telephone the Applicant's attorney at (703) 433-0510 in order that any outstanding issues be resolved.

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The Office is authorized to charge any fees required to deposit account number 50-1047.

Respectfully submitted,

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I hereby certify that this document and any document referenced herein is being sent to the United States Patent and Trademark office via Facsimile to: 703-872-9319 on April 10, 2003.

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(Printed Name of Person Mailing Correspondence)

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Version With Markings To Show Changes Made

IN THE CLAIMS:

1. (Amended) A trench MOSFET transistor device comprising:

a drain region of a first conductivity type;

a body region of a second conductivity type provided over said drain region, said drain region and said body region forming a first junction;

a source region of said first conductivity type provided over said body region, said source region and said body region forming a second junction;

source metal disposed on an upper surface of said source region;

a trench extending through said source region, through said body region and into said drain region; and

a gate region comprising an insulating layer lining at least a portion of said trench and a conductive region within said trench adjacent said insulating layer,

wherein (a) said body region is separated from said source metal, and (b) a doping profile along a line normal to upper and lower surfaces of said device is such that, (i) the doping profile is non-uniform within the body region, and (ii) within said body region and within at least a portion of said source and drain regions, the doping profile on one side of a centerplane of the body region is substantially symmetric with the doping profile on an opposite side of the centerplane.

14. (Amended) A trench MOSFET transistor device comprising:

a silicon drain region of N-type conductivity;

a silicon body region of P-type conductivity provided over said drain region, said drain region and said body region forming a first junction;

a silicon source region of N-type conductivity provided over said body region, said source region and said body region forming a second junction;

source metal disposed on an upper surface of said source region;

a trench extending through said source region, through said body region and into said drain region; and

a gate region comprising a silicon dioxide layer lining at least a portion of said trench and a doped polycrystalline silicon region within said trench adjacent said silicon dioxide layer,

wherein (a) said body region is separated from said source metal by said source region, (b) said source and drain regions comprise the same doping material, (c) said source and drain regions have peak net doping concentrations that are greater than a peak net doping concentration of said body region, and (d) a doping profile along a line normal to upper and lower surfaces of said device is such that, (i) the doping profile is non-uniform within the body region, and (ii) within said body region and within at least a portion of said source and drain regions, the doping profile on one side of a centerplane of the body region is substantially symmetric with the doping profile on an opposite side of said centerplane.